

(12) PATENT ABRIDGMENT (11) Document No. AU-B-66790/90  
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 610786

(54) Title  
**LOST-FOAM CASTING OF DUAL ALLOY ENGINE BLOCK**

**International Patent Classification(s)**

(51)<sup>5</sup> B22C 007/02 B22C 009/04 B22D 019/16 B22D 021/04  
B22D 023/02

(30) Priority Data

(31) Number      (32) Date      (33) Country  
445205            04.12.89        US UNITED STATES OF AMERICA

(43) Publication Date : 23.05.91

(44) Publication Date of Accepted Application : 23.05.91

(71) Applicant(s)  
**GENERAL MOTORS CORPORATION**

(72) Inventor(s)  
**RICHARD J. OSBORNE**

(74) Attorney or Agent  
PHILLIPS ORMONDE & FITZPATRICK, 367 Collins Street, MELBOURNE VIC 3000

(56) Prior Art Documents  
EP 281752  
EP 149211

(57) Claim

1. A lost-foam casting process for producing a compound alloy product casting comprising a first section formed of a first metal alloy and a second section formed of a second metal alloy distinct from the first alloy, said process comprising embedding an expendable pattern in an unbonded particulate mould, said pattern being formed of a polymeric material thermally decomposable at metal-casting temperatures and comprising a product portion corresponding to said product casting and having a first portion and a second portion corresponding to said first and second sections of the product casting, respectively, said pattern further comprising a first runner system including a melt pour surface connected to said first portion of the pattern and a second runner system having a melt pour surface distinct from the first runner melt

pour surface and connected to said second portion of the pattern, said pattern being embedded in the mould so that the first runner melt pour surface and the second runner melt pour surface are exposed and spaced apart for independent contact with cast metal; casting molten first metal alloy into contact with the first runner melt pour surface to decompose and replace said first portion of the pattern; concurrently casting molten second metal alloy into contact with the second runner melt pour surface to decompose and replace the second portion of the pattern, said casting of said alloys continuing so as to decompose and replace the entire pattern, whereupon the two molten alloys flow together; solidifying the two cast alloys to form the product casting, whereupon the alloys fuse to produce an integral product casting; and removing the cast metal product casting from the mould and separating the cast metal corresponding to the first and second runner systems from the product casting.

7. A compound metal alloy, lost-foam engine block casting produced by a process according to claim 3, comprising a crankcase section, a cylinder wall section extending from said crankcase section and a water jacket wall extending from the crankcase section about the cylinder wall section but spaced apart therefrom, said cylinder wall section defining at least one cylinder bore and having a head end remote from the crankcase section and a piston-travel region adjacent said head end, said engine block casting being characterized in that the piston-travel region is cast of said first metal alloy and the crankcase section and water jacket wall are cast of said second metal alloy distinct from the first metal alloy, said first alloy and second alloy being fused together to form an integral casting.

AUSTRALIA

Patents Act

COMPLETE SPECIFICATION  
(ORIGINAL)

610786

Class Int. Class

Application Number:  
Lodged:

Complete Specification Lodged:  
Accepted:  
Published:

Priority

Related Art:

Applicant(s):

General Motors Corporation  
West Grand Boulevard and Cass Avenue, Detroit, Michigan, 48202,  
UNITED STATES OF AMERICA

Address for Service is:

PHILLIPS ORMONDE & FITZPATRICK  
Patent and Trade Mark Attorneys  
367 Collins Street  
Melbourne 3000 AUSTRALIA

Complete Specification for the invention entitled:

LOST-FOAM CASTING OF DUAL ALLOY ENGINE BLOCK

Our Ref : 198057  
POF Code: 1221/1695

The following statement is a full description of this invention, including  
the best method of performing it known to applicant(s):

LOST-FoAM CASTING OF DUAL ALLOY ENGINE BLOCK

This invention relates to a lost-foam metal casting process that comprises independently and concurrently casting two metal alloys to form a casting body. More particularly, this invention 5 relates to a lost-foam engine block casting comprising distinct sections formed of different aluminium alloys that are concurrently cast to form a dual alloy engine block.

In a typical lost-foam casting process, a 10 pattern is formed of a polymeric material vaporizable at metal casting temperatures, such as moulded expanded polystyrene. The pattern is embedded in an unbonded sand body to form a foundry mould. Molten metal is cast into the mould in contact with the 15 pattern, whereupon the metal progressively decomposes and replaces the pattern. In this manner, the pattern is duplicated by the metal, whereafter the metal solidifies to form a product casting.

A common internal combustion engine of the 20 type employed to power automotive vehicles comprises an engine block formed of a relatively massive and complex metal casting. Depending upon the particular engine design, the engine block casting comprises one or more walls that define a desired number of 25 cylinder bores. During engine operation, a piston reciprocates within each bore to drive a common crankshaft. The crankshaft is housed within a crankcase formed at least in part by a section of the engine block casting. Also, the engine block 30 casting comprises an outer wall located about the cylinder walls, but spaced apart therefrom to define a water jacket through which coolant is circulated

during engine operation. Thus, the engine block is formed of a single casting that comprises a cylinder wall section, a crankcase section and a water jacket wall section.

5           Although historically most engine blocks have been formed of cast iron, engine blocks have also been formed of aluminium castings. Aluminium blocks have been cast by empty-cavity processes such as die-casting or permanent mould casting. It has  
10          also been proposed to cast aluminium blocks by a lost-foam process. Aluminium alloys of the type used in engine blocks have properties dependent upon the silicon content thereof and are described by reference to a low-melting eutectic composition  
15          formed between aluminium and about 12 percent silicon. Hyper-eutectic alloys contain silicon in an amount greater than the eutectic composition and are characterized by the presence of free silicon particles dispersed in a eutectic matrix. The free  
20          silicon particles form a hard phase that improves wear resistance. This wear resistance is desired in the bore wall to reduce scuffing by the piston. However, hyper-eutectic alloys are more difficult to cast, particularly in a large body such as an  
25          engine block. Early precipitation of the silicon particles hinders the flow of feed metal into slowly solidifying, interior regions of the casting, resulting in increased macroporosity of the casting. Also, hyper-eutectic alloys exhibit increased  
30          microporosity attributed to added heat released during silicon precipitation and increased thermal contraction during cooling. Although desired for

cylinder walls, the hyper-eutectic alloy renders the casting more difficult to machine, as evidenced by increased tool wear, and is not considered advantageous in sections remote from the cylinder wall. Of particular significance to this invention, the casting of hyper-eutectic alloy by a lost-foam process presents difficulties peculiar to that process. Loss of heat at the melt front adjacent the decomposing pattern results in premature solidification, as evidenced by cold-fold defects in the product casting.

On the other hand, hypo-eutectic alloys, which contain less silicon than the eutectic composition, are characterized by dispersed aluminium particles that are soft in contrast to the hard silicon particles in the hyper-eutectic alloy. This facilitates machining of the casting, but also increases wear at the bore wall. It is known to insert a tubular liner formed of wear-resistant alloys, such as cast iron or hyper-eutectic aluminium alloy, into cylinder bores in the hypo-eutectic casting to provide a satisfactory piston contact surface. Liners require precision machining of both inner diameter and outer diameter surfaces and careful assembling into the engine block to obtain a proper fit, thereby adding significantly to the cost of the engine. Also, depending upon engine design, stresses created by differential thermal expansion between the liner and the surrounding cylinder wall may result in crack formation during engine operation.

For these reasons, engine block castings

formed solely of hyper-eutectic alloy or formed solely of hypo-eutectic alloy have not been entirely satisfactory.

A lost-foam casting process according to  
5 the invention, for producing a compound alloy product  
casting comprising a first section formed of a first  
metal alloy and a second section formed of a second  
metal alloy distinct from the first alloy, comprises  
embedding an expendable pattern in an unbonded  
10 particulate mould, said pattern being formed of a  
polymeric material thermally decomposable at  
metal-casting temperatures and comprising a product  
portion corresponding to said product casting and  
having a first portion and a second portion  
15 corresponding to said first and second sections of  
the product casting, respectively, said pattern  
further comprising a first runner system including a  
melt pour surface connected to said first portion of  
the pattern and a second runner system having a melt  
20 pour surface distinct from the first runner melt pour  
surface and connected to said second portion of the  
pattern, said pattern being embedded in the mould so  
that the first runner melt pour surface and the  
second runner melt pour surface are exposed and  
25 spaced apart for independent contact with cast  
metal; casting molten first metal alloy into contact  
with the first runner melt pour surface to decompose  
and replace said first portion of the pattern;  
concurrently casting molten second metal alloy into  
30 contact with the second runner melt pour surface to  
decompose and replace the second portion of the  
pattern, said casting of said alloys continuing so as

to decompose and replace the entire pattern,  
whereupon the two molten alloys flow together;  
solidifying the two cast alloys to form the product  
casting, whereupon the alloys fuse to produce an  
5 integral product casting; and removing the cast metal  
product casting from the mould and separating the  
cast metal corresponding to the first and second  
runner systems from the product casting.

It is an object of this invention to  
10 provide an integral casting formed by a lost-foam  
process and comprising a first section formed of a  
first alloy and an independently but concurrently  
cast second section formed of a second alloy  
compositionally distinct from the first alloy.

15 It is a more particular object of this  
invention to provide a compound aluminium alloy  
engine block casting comprising a cylinder bore wall  
section formed of a first alloy, preferably hyper-  
eutectic aluminium alloy, and a remainder formed of a  
20 second alloy compositionally distinct from the first  
alloy, preferably hypo-eutectic aluminium alloy.

It is also an object of this invention to  
provide a lost-foam process for casting metal which  
comprises providing an expendable pattern having  
25 portions corresponding to sections in the product,  
and casting a first alloy to replace a first portion  
of the pattern and a compositionally distinct second  
alloy to replace a second portion of the pattern,  
such that the resulting integral product comprises  
30 a first section formed of the first alloy and a  
second section formed of the second alloy.

It is a more particular object of this invention to provide a lost-foam casting process for producing an engine block casting from a pattern sized and shaped corresponding to the desired engine  
5 block configuration, which process comprises casting a melt of a hyper-eutectic alloy to duplicate a portion of the pattern corresponding to an engine wall section of the engine block casting and independently casting a hypo-eutectic alloy to  
10 replace portions of the pattern corresponding to a crankcase section and a water jacket wall section.

In a preferred embodiment of the present invention, these and other objects are accomplished by a lost-foam casting process for producing a  
15 compound aluminium alloy engine block casting that comprises a cylinder wall section formed of a hyper-eutectic aluminium alloy and crankcase section and a water jacket wall section formed of hypo-eutectic aluminium alloy. The process utilizes an expendable pattern comprising a product portion sized and shaped corresponding to the desired engine block casting configuration. The engine block pattern comprises portions corresponding to a crankcase section, a cylinder wall section and a water jacket wall  
25 section in the engine block casting. The pattern comprises a first runner system having a melt pour surface. The first runner system is connected to the cylinder wall portion of the pattern for conveying molten metal from the melt pour surface to the  
30 cylinder wall portion. The pattern further comprises a second runner system having a melt pour surface independent from the first runner melt pour surface.

The second runner system is connected to the water jacket wall portion at one or more regions spaced apart from the cylinder wall portion and is adapted for conveying molten metal from the second runner

- 5 melt pour surface to the cylinder wall portion. The pattern is formed by assembling, using a vaporizable adhesive, individually-moulded portions formed of expanded polystyrene or the like. The assembled pattern is embedded in a body of unbonded sand  
10 particles to produce a mould. The pattern is arranged in the mould such that the first runner melt pour surface and the second runner melt pour surface are exposed and spaced apart for independent contact with cast metal.

15 In accordance with this invention, a first charge of molten hyper-eutectic aluminium-silicon alloy is cast into contact with the first runner melt pour surface. Upon contact with the pattern, the molten metal progressively decomposes and replaces  
20 the first runner system and thereafter the cylinder wall portion of the pattern. A second charge of a hypo-eutectic aluminium alloy is cast against the second runner melt pour surface, whereupon the charge progressively decomposes and replaces the second melt runner system and thereafter the water jacket wall portion and crankcase portion of the engine block pattern. Eventually, the entire product  
25 pattern portion is consumed and replaced, whereupon the two charges flow together and fuse to produce  
30 an integral casting. The two molten charges are cast concurrently, by which is meant that the charges are cast simultaneously or, if cast successively, are

cast in such close succession, for example a few seconds, that the latter cast charge is poured before the earlier cast charge has solidified. The line of fusion at which the charges flow together is

5 determined by the relative volumes of the charges.

In a preferred embodiment, the volume of cast hyper-eutectic alloy is sufficient to replace a region of the cylinder wall over which the piston travels during engine operation. The melt front 10 for the hyper-eutectic alloy thus terminates at a line proximate to the crankcase section. The volume of hypo-eutectic alloy used is sufficient to replace the balance of the pattern, whereupon the hypo-eutectic alloy front flows against the 15 hyper-eutectic front to fuse the independent charges, into a single product casting. Following solidification of the dual cast alloys, the product engine block casting is removed from the mould and separated from the runner systems.

20 Therefore, the engine block casting of this invention thus comprises a cylinder wall section formed of hyper-eutectic aluminium-silicon alloy and a remainder, including the water jacket wall and the crankcase section, formed of hypo-eutectic 25 aluminium-silicon alloy. Thus, this invention provides the wear resistance advantages of the hyper-eutectic alloy in the critical region of the cylinder wall section without the disadvantages of high porosity, cold-folds and reduced machinability 30 within more massive regions of the casting, and at the same time produces a sound casting throughout the crankcase section and the water jacket wall section

of hypo-eutectic alloy which may be readily machined to drill and tap holes and finish other features in the engine block, without suffering the disadvantages of a soft cylinder bore wall that would otherwise necessitate cylinder liners at additional cost.

5 Furthermore, the process of this invention may be readily carried out in a single mould to produce a single product casting, thereby reducing the cost of the product engine block.

10 The invention and how it may be performed are hereinafter particularly described with reference to the accompanying drawings, in which:

15 Figure 1 is a cross-sectional view of a foundry mould comprising an expendable polymeric engine block pattern for casting by a lost-foam process;

20 Figure 2 is a cross-sectional view, partially cut-away, of the mould shown in Figure 1, taken along the lines 2-2 and looking in the direction of the arrows;

25 Figure 3 is a cross-sectional view of a portion of the mould shown in Figure 1, taken along the line 3-3 and looking in the direction of the arrows;

30 Figure 4 is a perspective view showing a portion of a runner system for the pattern shown in Figure 1, sectioned along the plane of attachment to the product portion;

Figure 5 is a perspective view of a preferred dual aluminium alloy engine block casting of this invention; and

Figure 6 is a cross-sectional view of the engine block casting shown in Figure 5, taken along line 6-6 and looking in the direction of the arrows.

In a preferred embodiment of this invention as shown in the drawings, a compound aluminium alloy engine block casting is cast by a lost-foam process. Referring to Figures 5 and 6, there is depicted an engine block casting 10 for an automotive L-4 spark-ignition engine. Engine block casting 10, shown in an upright orientation, comprises a base crankcase section 12 that defines a portion of the crankcase and includes crankshaft bearing supports 14 and a cylinder head deck 16 opposite crankcase section 12. Extending between crankcase section 12 and deck 16 are a cylinder wall section 18 and an outer water jacket wall 20, which are spaced apart to define a water jacket 22 through which coolant is circulated during engine operation. In this example, cylinder wall 18 defines four parallel cylinder bores 24 that extend from deck 16 to crankcase 12 and are aligned along centreline 25 such that each cylinder bore centre axis 23 perpendicularly intersects centreline 25. In this example, the cylinder bores 24 are arranged in a Siamese fashion; that is, adjacent bores are separated by a common wall. One consequence of this Siamese arrangement is that all four bores 24 are defined by a single continuous wall. However, this invention is also suitable for casting an engine block having cylinder walls defined by distinct tubular walls spaced apart by water coolant passages. Each bore 24 is adapted to receive a piston of the engine and includes an

end 21 at cylinder head deck 16 and including a region 26 over which the piston reciprocally travels during engine operation. In accordance with this invention, at least the piston-travel sub-section 5 26 is cast of a wear-resistant alloy compositionally different from crankcase section 12 and water jacket wall 20.

Referring to Figure 1, there is shown a foundry mould 30 for the lost-foam casting of engine 10 block casting 10. Mould 30 comprises a body 31 of unbonded lake sand particles packed about a pattern 32 composed of expanded polystyrene material thermally-decomposable at aluminium casting temperatures. Sand body 31 is contained within a 15 flask 27 supported by perforated lower wall 28. Flask 27 comprises a plenum 29 opposite perforated wall 28 from sand body 31 and connected to an external vacuum pump 33. Perforated wall 28 retains the sand particles whilst permitting pattern 20 decomposition vapors to vent into evacuated plenum 29 during casting.

Pattern 32 includes an engine block pattern 34 sized and shaped corresponding to engine block casting 10. As used herein, portions refer to 25 portions of the pattern corresponding to sections of casting 10. Thus, engine block pattern 34 includes a crankcase portion 36 corresponding to casting crankcase section 12, a cylinder wall portion 38 corresponding to casting cylinder wall section 18, 30 and a jacket wall portion 40 corresponding to casting jacket wall 20. Bores 42 having parallel centre axes 43 are defined in cylinder wall portion 38 to shape

cylinder bores 24 in the casting 10. Product pattern 34 also includes a surface 44 for forming cylinder head deck 16. As can be seen from the drawings, product pattern 34 is arranged within mould 30 in an inverted position such that cylinder head deck surface 44 represents a lowermost surface of product pattern 34.

Pattern 32 further comprises a first runner system 50 also formed of expanded polystyrene material. Runner system 50 comprises a downspur 52 having a melt pour surface 54 (shown replaced by cast metal) exposed above sand body 31 for admitting molten metal during casting. Downspur 52 is connected at its lowermost point to a stepped runner 56 that lies adjacent cylinder wall section 38 of product pattern 34 parallel to line 59 corresponding to engine block centreline 25, such that each cylinder bore axis 43 perpendicularly intersects line 59. Stepped runner 56 is connected to cylinder wall portion 38 by a series of aligned ingates 58. As can be seen in Figures 3 and 4, ingates 58 connect to cylinder wall section 38 at each interbore site and at sites at the ends of the bore arrangement. In this manner, runner system 50 connects melt pour surface 54 and cylinder wall portion 38. Runner 56 includes steps between ingates 58 for more uniform melt flow through the ingates into cylinder wall portion 38.

Pattern 32 further comprises a second runner system 60 also composed of expanded polystyrene material. Runner system 60 comprises a downspur 62 having a melt pour surface 64 (shown

replaced by metal during casting) exposed above sand body 31 and spaced apart from first runner melt pour surface 54. Downsprue 62 is connected at its lowermost point to a runner 65 comprising branches 5 66 that extend generally parallel to line 59 on each side of runner 56, but separated by sand mould 31 to prevent intermixing of metals conveyed by the runner systems. Branches 66 lie adjacent water jacket wall portion 40 and are connected thereto by ingates 68.

10 Being formed of decomposable polystyrene, second runner system 60 is thus suitable for conveying metal from melt pour surface 64 to water jacket wall portion 40 of product pattern 34.

Pattern 32 is manufactured by adhesively bonding individually-moulded polystyrene elements into a single body. A thin, porous refractory coating, similar to a core wash, is then applied to the exterior surfaces, except melt pour surfaces 54 and 64, to improve casting surface finish and 20 provide thermal insulation during casting to prevent premature metal solidification. Pattern 32 is then positioned within flask 27 whilst empty, whereafter unbonded sand is rained into the flask 27, whilst vibrating the flask gently, to pack the sand about 25 pattern 32 to form the mould. Pour cups 70 and 72 are then placed about melt pour surfaces 54 and 64, respectively, on the surface of sand 31 to direct molten metal into downsprues 52 and 62.

For casting engine block casting 10 in 30 accordance with this invention, a first charge 80 is prepared of a hyper-eutectic aluminium alloy designated aluminium alloy 390 by the American

Society for Metals. A nominal composition for aluminium alloy 390 comprises, by weight, 4 to 5 percent copper, 0.45 to 0.65 percent magnesium, 16 to 18 percent silicon, and the balance aluminium  
5 and impurities. Charge 80 is poured from a ladle 82 into pour cup 70 and against melt pour surface 54. Heat from the molten metal decomposes the adjacent polystyrene, whereupon the metal melt flows into the resulting void. In this manner, the molten metal  
10 progressively decomposes and replaces downspur 52, runner 56, and ingates 58 and eventually cylinder wall portion 38. The steps in runner 56 provide more uniform melt flow through ingates 58 despite the varying distances from downspur 52 and thereby  
15 produces more uniform replacement of cylinder wall portion 38.

Following the pouring of the first charge, a second aluminium alloy charge 84 is poured from a ladle 86 into pour cup 72 against melt pour surface 64. The second charge is made of a hypo-eutectic aluminium alloy designated alloy 319 by the American Society for Metals and having a nominal composition of, by weight, 3 to 4 percent copper, 5.5 to 6.5 percent silicon and the remainder aluminium and impurities. In a manner described herein concerning the casting of the first charge, charge 84 progressively decomposes and replaces downspur 62 and runner 65, including branches 66, and thereafter passes through ingates 68 to replace water jacket wall portion 40. The volume of charge 84 is adjusted to replace not only water jacket wall portion 40, but also crankcase portion 36 and the region of cylinder  
20  
25  
30

wall portion 38 adjacent the crankcase portion. That is, charge 84 is sufficient to replace the remainder of pattern 34 not consumed by charge 80. In this manner, the entire pattern is duplicated, whereupon  
5 the cast aluminium alloy 319 of charge 84 flows against the cast aluminium alloy 390 of charge 80. At this juncture, shown at 90 in Figure 6, the two charges fuse together, producing a single body of cast metal.

10 After cooling and solidifying, the casting is removed from the mould, and sections corresponding to runners 50 and 60 are separated to produce engine block casting 10 shown in Figures 5 and 6. As can be seen, piston-travel sub-section 26 of cylinder wall  
15 section 24 is cast of wear-resistant hyper-eutectic aluminium-silicon alloy 390. The remainder including crankcase section 12 and water jacket wall 20 is cast of hypo-eutectic aluminium-silicon alloy 319. The two alloys are fused at 90 so that the resulting  
20 casting 10 is an integral metal body.

This engine block casting thus combines the advantages of the hyper-eutectic alloy in the cylinder wall section and the advantages of the hypo-eutectic alloy in the remainder, without the  
25 disadvantages of the soft hypo-eutectic alloy in the cylinder wall region and the porosity and poor machinability of the hyper-eutectic alloy in the bulk of the casting.

In the described embodiment, a compound  
30 aluminium alloy engine block casting was produced by a lost-foam process wherein two charges of compositionally different metal were independently

and concurrently cast into the mould to replace a single pattern. The process of decomposing and replacing the polystyrene produces resistance to melt flow not found in empty cavity casting processes.

- 5 This is accompanied by a controlled fill that allows a relative uniform flow of aluminium alloy 390 into the piston-travel sub-section 26 of the cylinder wall section of the casting. It is also accompanied by reduced turbulence and setting of the metal at each
- 10 melt front that permit the two fronts to flow together with minimal intermixing that would otherwise dilute the desired properties of the individual alloys. In forming the dual alloy engine block casting, the volume of hyper-eutectic alloy
- 15 is calculated to replace a predetermined portion of the cylinder wall section. The volume of hypo-eutectic alloy is controlled to provide sufficient metal to replace the remainder of the pattern without forcing metal back from sub-section
- 20 26 into first runner system 50. In the described embodiment, the relative volumes of the cast metal produced a line of fusion within the cylinder wall section. Alternately, the relative volumes may be adjusted to form the line of fusion elsewhere within
- 25 the product casting. For example, the relative volume of hyper-eutectic alloy may be increased to consume part of the crankcase portion, whereupon the resulting line of fusion may be formed within the crankcase section.
- 30 Whilst the dual alloy casting process of this invention has been disclosed for making a preferred engine block casting, the process is

suitable for producing integral castings having configurations intended for other purposes, but which feature distinct sections of dissimilar metals.

Also, whilst in the described embodiment the

5 casting was formed of a combination of hyper-eutectic aluminium alloy and hypo-eutectic aluminium alloy, the method is suitable for casting other combinations of dissimilar aluminium or non-aluminium metals. For example, the method may be adapted for casting  
10 different types of iron alloys, such as nodular iron and gray iron. In accordance with this invention, two different alloys are concurrently cast into a single mould. Both alloys may be simultaneously poured into the mould, or the alloys may be cast in  
15 succession, as in the described embodiment. It is preferred to cast the latter charge before the first charge has completely solidified. Typically, the casting of both metals may be completed within a few seconds of one another.

20 While this invention has been described in terms of certain embodiments thereof, it is not intended that it be limited solely to the above description of the preferred embodiment of the invention, but rather only to the extent set forth  
25 in the claims that follow.

The claims defining the invention are as follows:

1. A lost-foam casting process for producing a compound alloy product casting comprising  
5 a first section formed of a first metal alloy and a second section formed of a second metal alloy distinct from the first alloy, said process comprising embedding an expendable pattern in an unbonded particulate mould, said pattern being  
10 formed of a polymeric material thermally decomposable at metal-casting temperatures and comprising a product portion corresponding to said product casting and having a first portion and a second portion corresponding to said first and second sections of  
15 the product casting, respectively, said pattern further comprising a first runner system including a melt pour surface connected to said first portion of the pattern and a second runner system having a melt pour surface distinct from the first runner melt  
20 pour surface and connected to said second portion of the pattern, said pattern being embedded in the mould so that the first runner melt pour surface and the second runner melt pour surface are exposed and spaced apart for independent contact with cast  
25 metal; casting molten first metal alloy into contact with the first runner melt pour surface to decompose and replace said first portion of the pattern; concurrently casting molten second metal alloy into contact with the second runner melt pour surface  
30 to decompose and replace the second portion of the pattern, said casting of said alloys continuing so as to decompose and replace the entire pattern.

whereupon the two molten alloys flow together; solidifying the two cast alloys to form the product casting, whereupon the alloys fuse to produce an integral product casting; and removing the cast 5 metal product casting from the mould and separating the cast metal corresponding to the first and second runner systems from the product casting.

2. A lost-foam casting process according to claim 1, in which the first metal alloy is a 10 hyper-eutectic aluminium-silicon alloy and the second metal alloy is a hypo-eutectic aluminium-silicon alloy.

3. A lost-foam casting process according to claim 1 or 2, for producing a compound alloy 15 engine block casting, said engine block casting comprising a crankcase section, a cylinder wall section extending from the crankcase section and a water jacket wall also extending from the crankcase section about the cylinder wall section but spaced 20 apart therefrom, with said cylinder wall section defining at least one cylinder bore and having a piston-travel region adjacent an outer end remote from the crankcase section; in which process said engine block casting is formed of said two metal 25 alloys such that said cylinder wall piston-travel region is composed of said first metal alloy and said crankcase section and said water jacket wall are composed of said second alloy; said expendable pattern comprises a product form substantially 30 sized and shaped to produce the engine block casting and having said first portion corresponding to the cylinder wall section, and having said second portion

corresponding to the crankcase section and the water jacket wall; said first runner system is connected to the cylinder wall portion; said second runner system is connected to the water jacket wall portion; the  
5 molten first alloy is cast into contact with the first runner system melt pour surface to decompose and replace at least the piston-travel region of the cylinder wall section of the pattern; the molten second alloy is concurrently cast into contact with  
10 the second runner system melt pour surface to decompose and replace the water jacket wall portion and the crankcase portion of the pattern; said casting of said alloys continues so as to decompose and replace the entire pattern; and the cast alloys  
15 are then solidified to form the engine block casting.

4. A lost-foam casting produced by a process according to claim 1, comprising a first section of a first metal alloy and an independently and concurrently cast second section of a second metal alloy distinct from the first metal alloy, said alloys being fused into an integral product casting.  
20

5. A lost-foam casting according to claim 4, in which said first section is formed from a first aluminium alloy and said independently and  
25 concurrently cast second section is formed from a second aluminium alloy distinct from said first aluminium alloy.

6. A lost-foam casting according to claim 5, in which the first aluminium alloy is a hyper-eutectic aluminium-silicon alloy and the second aluminium alloy is a hypo-eutectic aluminium-silicon alloy.  
30

7. A compound metal alloy, lost-foam engine block casting produced by a process according to claim 3, comprising a crankcase section, a cylinder wall section extending from said crankcase section and a water jacket wall extending from the crankcase section about the cylinder wall section but spaced apart therefrom, said cylinder wall section defining at least one cylinder bore and having a head end remote from the crankcase section and a piston-travel region adjacent said head end, said engine block casting being characterized in that the piston-travel region is cast of said first metal alloy and the crankcase section and water jacket wall are cast of said second metal alloy distinct from the first metal alloy, said first alloy and second alloy being fused together to form an integral casting.

8. An engine block casting according to claim 7, in which the first metal alloy is an aluminium alloy and the second metal alloy is an aluminium alloy distinct from the first aluminium alloy,

9. An engine block casting according to claim 7, in which the first metal alloy is a hyper-eutectic aluminium-silicon alloy and the second metal alloy is a hypo-eutectic aluminium-silicon alloy.

10. A lost-foam casting process for producing a compound alloy product casting substantially as hereinbefore particularly described with reference to Figures 1 to 6 of the accompanying drawings.

11. A compound metal alloy, lost-foam engine block casting substantially as hereinbefore particularly described with reference to Figures 5 and 6 of the accompanying drawings.

DATED: 19 November 1990

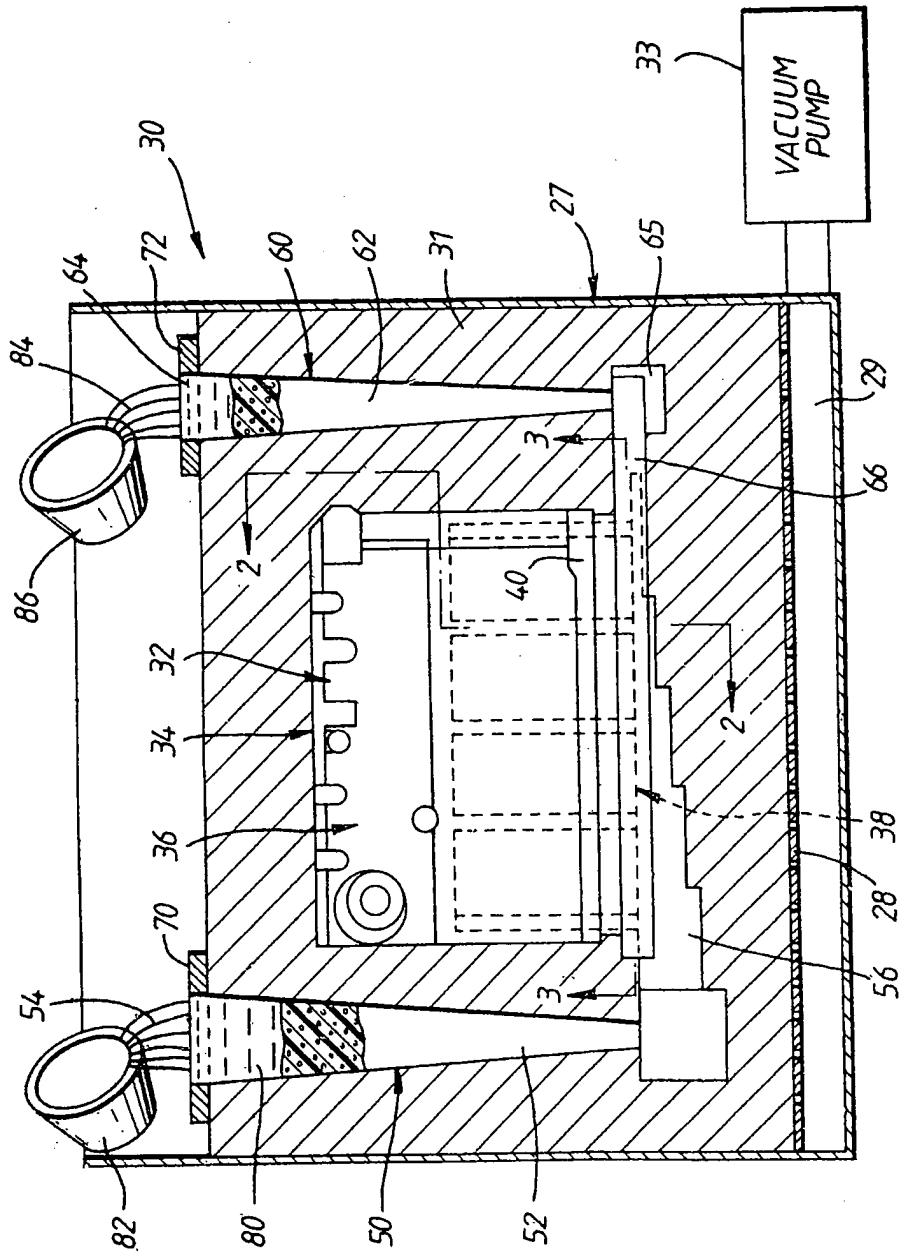
PHILLIPS ORMONDE & FITZPATRICK  
Attorneys for:  
GENERAL MOTORS CORPORATION

*David B Fitzpatrick*

卷之三

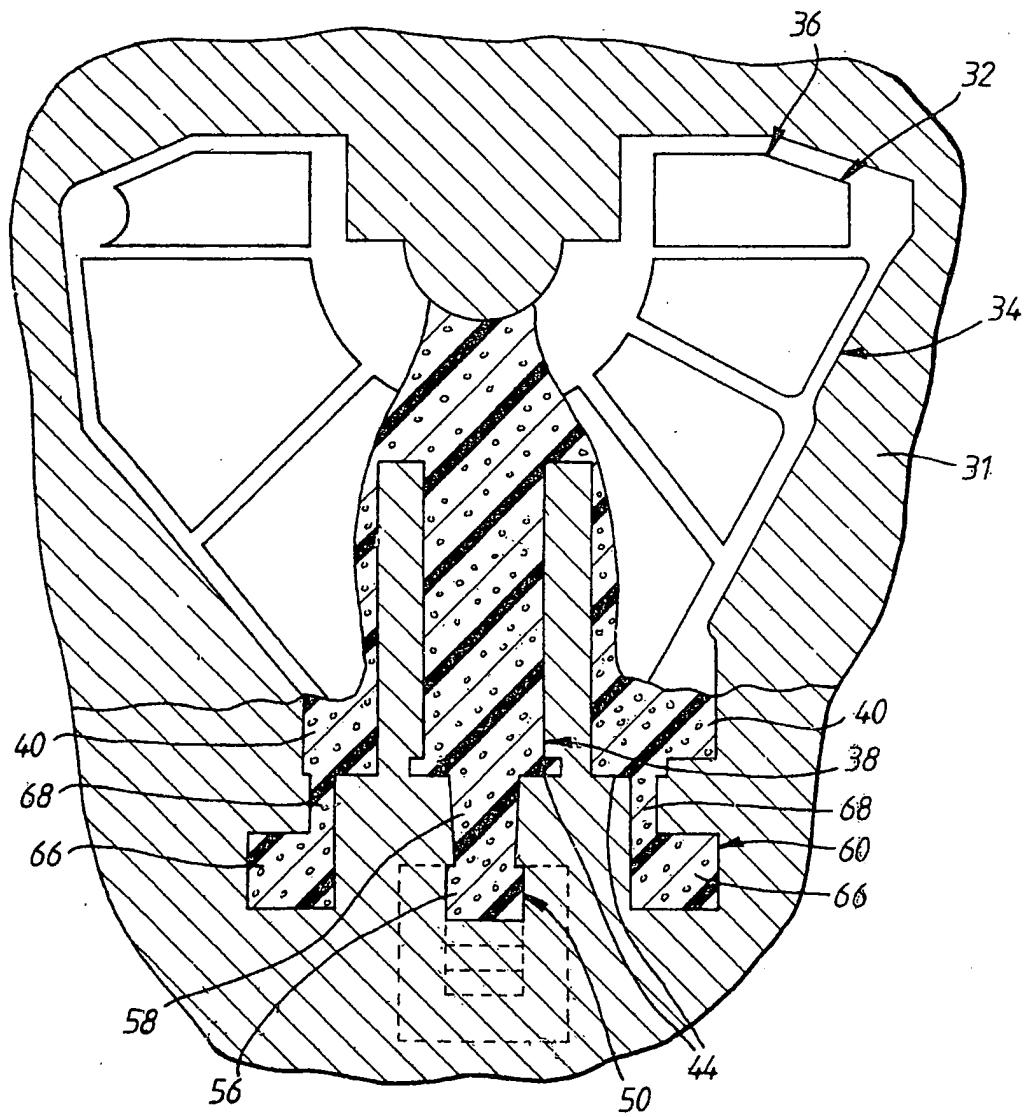
Fig. 1.

66790/90

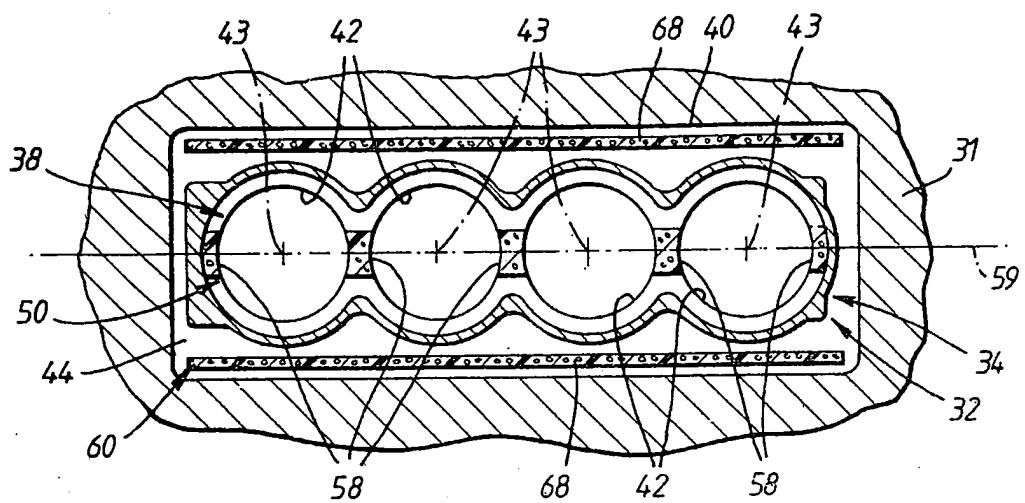


*Fig. 2.*

SEARCHED  
SERIALIZED  
INDEXED  
FILED



*Fig. 3.*



*Fig. 4.*

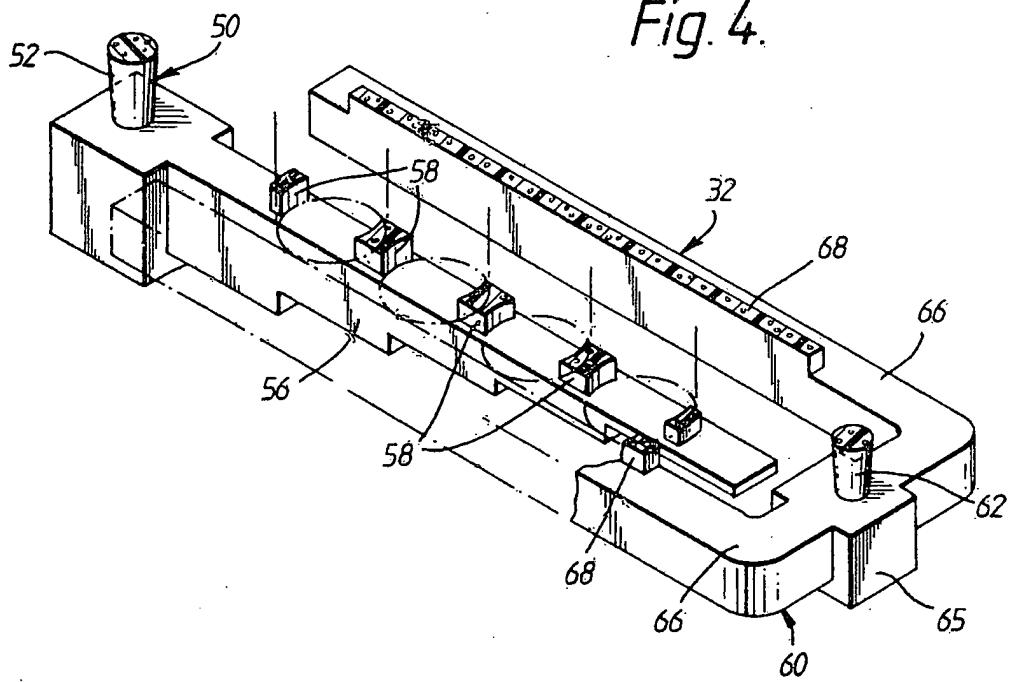


Fig. 5.

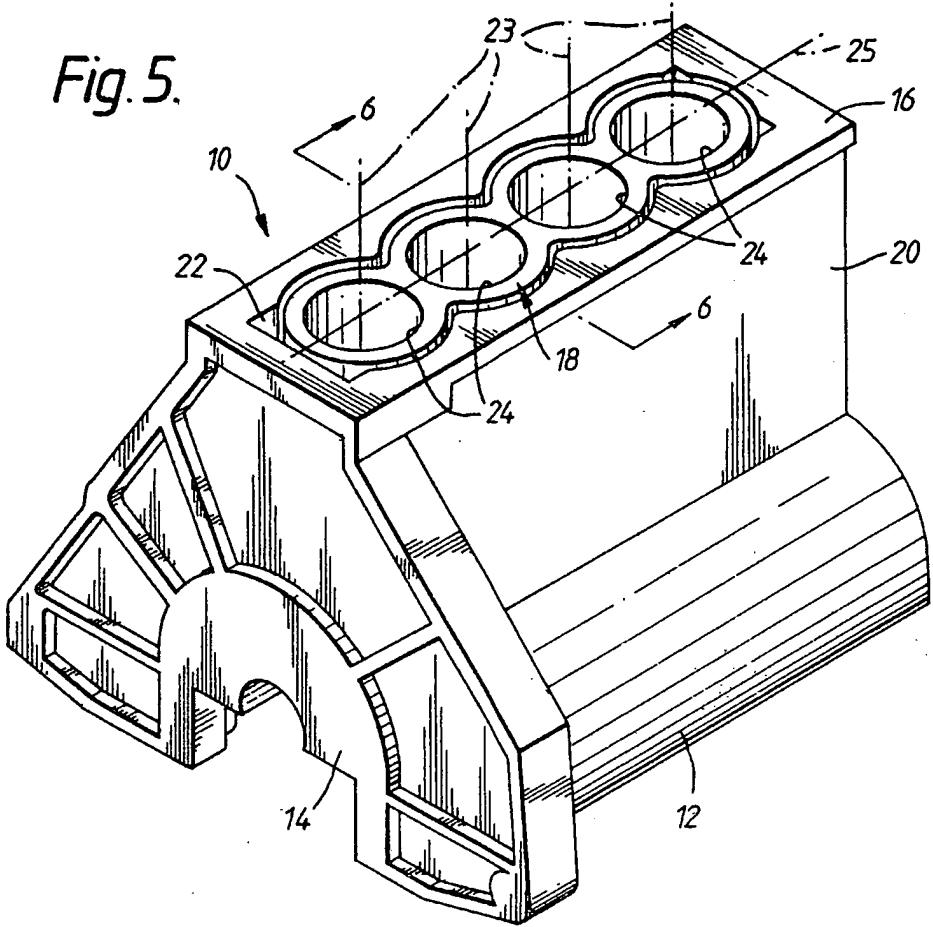


Fig. 6.

